Field Estimate of Available Disposal Space for Surface Mine Wastes at Galena, Kansas

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Introduction

Two previous field surveys (April and May 1988) have resulted in the location, characterization, and volume estimation of surface mine wastes in the Galena and other subsites of the Cherokee County Superfund Site in southeastern Kansas. During the second survey, a modest attempt was made to estimate the volume of open mine shafts or subsidence areas as they were encountered in the field. However, no attempt was made to locate all shafts, subsidence zones or pits, and the survey did not include the eight zones within the Galena subsite designated by EPA. A paper study of the 1983 McCauley data regarding subsidence zones, open pits, and mine shafts was done in June 1988 to further evaluate the possibilities of surface mine waste disposal. However, no field verfication of the McCauley data was conducted at that time.

In order to further consider and evaluate the possibility of surface mine waste disposal in the subsidence zones, open pits, and mine shafts in the Galena subsite, a detailed field survey of the Galena subsite was conducted from November 15-19, 1988. Figure 1 shows the location of the general study area. The survey was designed to verify the McCauley data and estimate available disposal space in the subsidence zones and open pits at Galena. No attempt was made to locate or measure the 377 mine shafts in the Galena area, although many were observed during the survey.

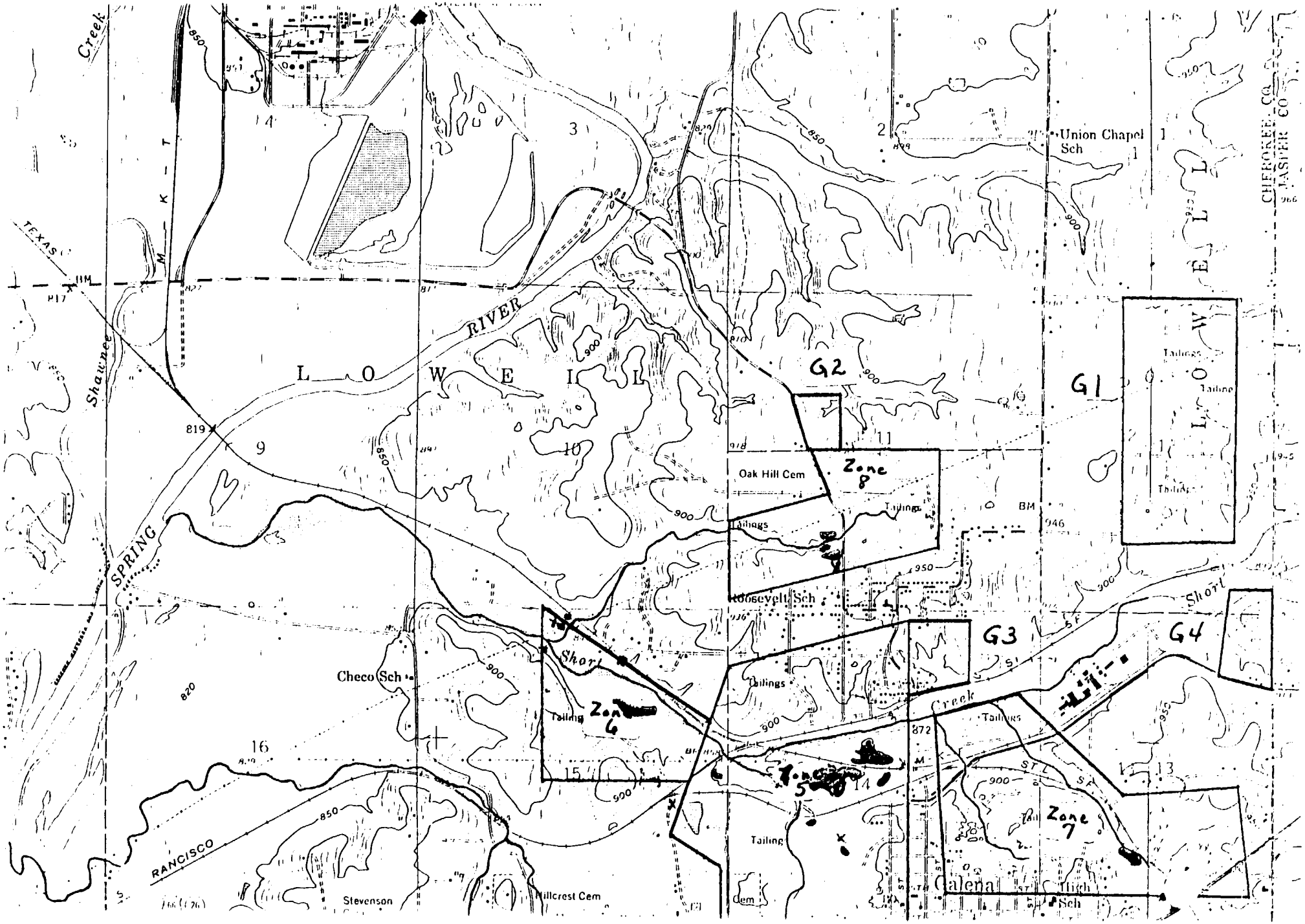
Procedures

Prior to the field survey the McCauley data, particularly Appendixes B, C-1, and C-2, were reviewed. The maps in Appendix B were enlarged to a scale equal to the 1978 aerial photos obtained from the Soil Conservation Service. These maps and photos were then utilized to locate the subsidence zones and open pits in the field.

Surface areas of each subsidence zone was estimated by actually pacing, or measuring with a 100 ft. steel tape, the circumference or diameter of the subsidence zone. For the large open pits, previous estimates of acreage from planimetering the aerial photos was utilized. For each subsidence zone or open pit an estimate of the depth was made to the bottom of the hole or to the water surface in the hole. If possible, a visual estimate of the water depth was made. Depth was estimated from the natural ground surface and did not include any additional height due to rock or chat piles around the edge of the subsidence or open pit area.

For those larger subsidence areas and open pits which contained deep water, an additional estimate of the water depth was necessary. This was accomplished by actually

Figure 1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Shawnee
SPRING
RIVER
L O W E I L
TEXAS
M K T
Union Chapel Sch
CHEROKEE CO
JASPER CO
G1
G2
G3
G4
Zone 8
Zone 7
Zone 6
Oak Hill Cem
Roosevelt Sch
Checo Sch
Short
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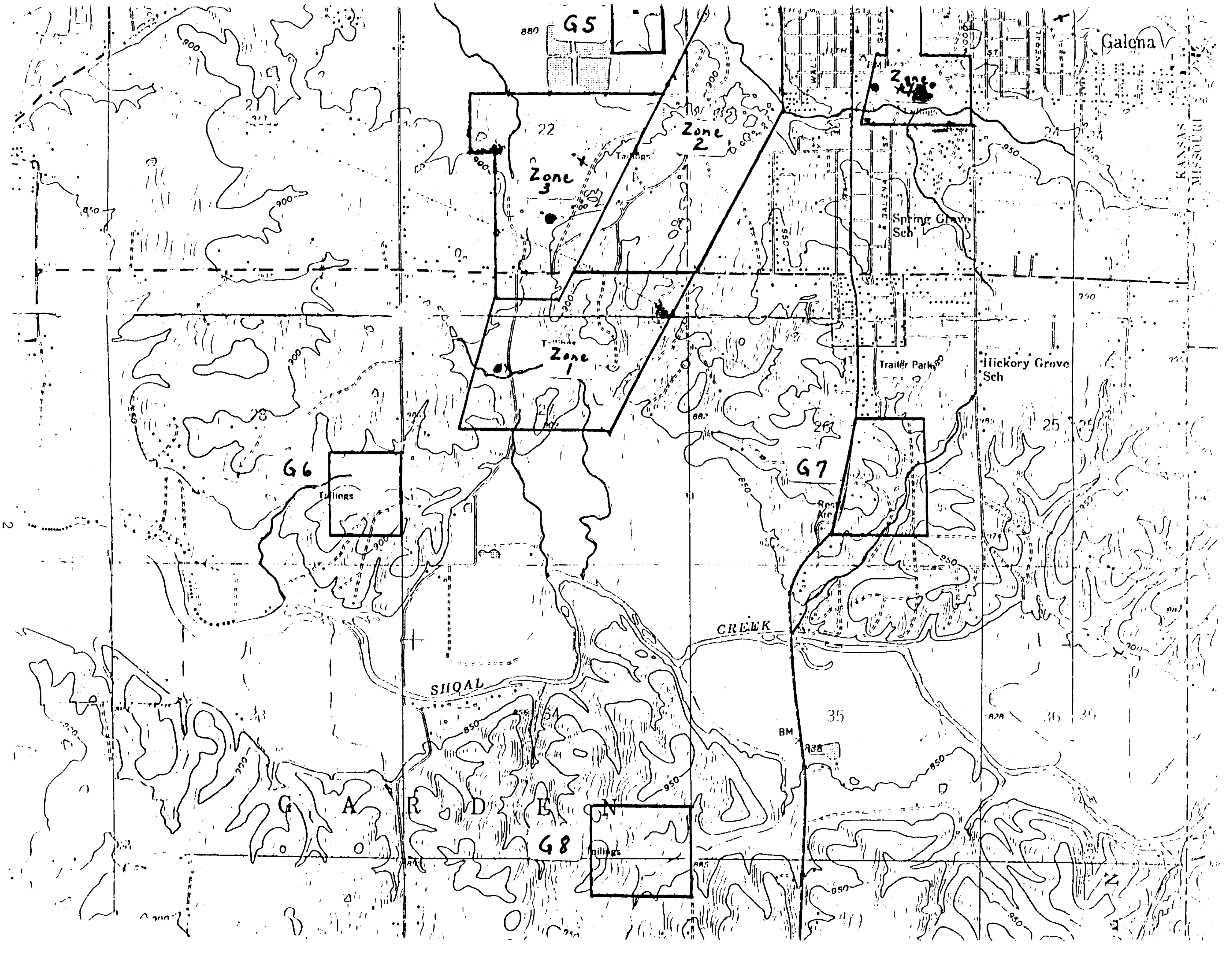

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Zone 2
Zone 3
Zone 1
Zone 4
G6
Tailings
G7
G8
Tailings
Galena
Spring Grove Sch
Hickory Grove Sch
Trailer Park
SHOAL
CREEK
GARDEN
KANSAS
MISSOURI
22
34
35
25
BM
900
950
850

floating on each "pond" in a rubber raft and taking depth measurements at several locations in the "pond" (ranging from five to eight points, depending on size) along cross sections. A total of twenty large areas were measured in this way. A metered fishing line with color changes every ten feet and a heavy sinker were lowered into each "pond" until the bottom was reached. Depth was then recorded to the nearest foot at each measuring point. Average depth of the "pond" was then calculated.

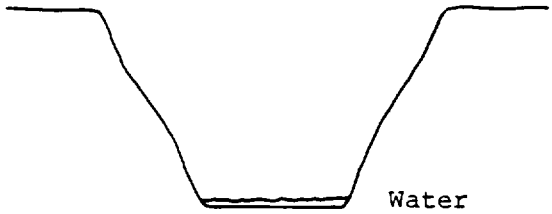
In addition to the depth estimates and based on the field observations, a characteristic shape was assigned to each subsidence zone or open pit for purposes of calculating volumes. The shapes utilized were an inverted cone, an inverted wedge or elongated cone, an inverted trapezoid, or an inverted box or cylinder. Based on field observations and measurements, the angle of repose of materials in the subsidence areas is around 45^{o}.

Based on the field observations each subsidence zone or open pit was classified for purposes of potential surface mine waste disposal procedures. Figure 2 illustrates these classifications. Areas which had dry bottoms or only contained water from the recent rain were classified as Type 1. Type 2 areas were those which contained deeper water, which did not appear to be solely due to runoff and probably representative of the groundwater level. Type 3 areas were ponds or open pits which contained water up to or nearly at the natural ground surface. Note was taken as to whether the groundwater level appeared to have varied in the past by looking for evidence of water lines.

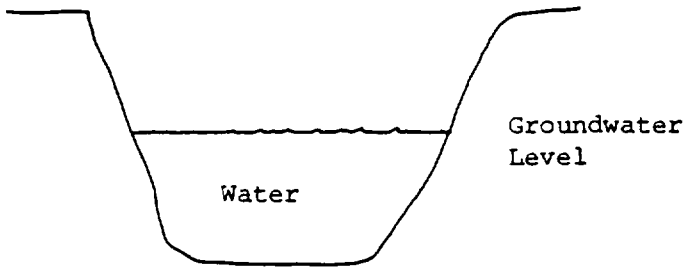
Results

During the 1983 study McCauley mapped and field verified the known mine subsidence zones, open pits, and mine shafts in the Galena subsite. His detailed maps by section are shown in Appendix A. Utilizing these maps and aerial photos in the field almost all of the areas were located. A few (about 20) minor subsidence areas were not located or measured or inaccessible due to "No Trespassing" signs. In addition, two of the areas in Zone 2 have been filled in by the City of Galena as a trash dump.

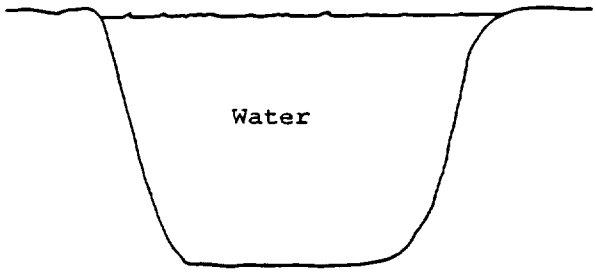
A total of 181 subsidence zones or open pits were located and measured. Of these, twenty were measured for water depth utilizing the rubber raft. Appendix B contains the results of the volume calculations and breakdown by hole type for each EPA zone. Of the 181 measured holes, 129 fall into the Type 1 or dry bottom variety while only four could be classified as Type 3 or surface water ponds. The remaining 48 holes contained water at varying levels from the surface and at various depths. Table 1 gives a further summary of hole type by EPA zone.



Type 1 - Dry bottom or minimal water from runoff in hole.



Type 2 - Deep water in hole representing groundwater level at that location.



Type 3 - Water in hole up to natural ground surface.

Figure 2. Classification Types for Subsidence Areas and Open Pits

Table 1

Breakdown of Number of Holes
by Type in Each EPA Zone

EPA Zone	Number of Holes			Total
	Type 1	Type 2	Type 3	
1	3	2	-	5
2	17	6	-	23
3	13	5	-	18
4	1	7	-	8
5	9	17	-	26
6	7	2	2	11
7	70	2	1	73
8	9	7	1	17
Total	129	48	4	181

Table 2 gives the average water depths for the twenty holes measured in the study area. The large open pit (#5-12 OP) along Short Creek and the Blue Hole (#4-12 [10]) in Zone 4 had the greatest depths. Depth of the other large open pit (#5-70P) along Short Creek was not measured. It appears that the water level in the subsidence zones and open pits along Short Creek approximate the creek level although an actual survey would be necessary to accurately measure such. It should also be noted that streams flow directly into holes 1-4 and 7-20 and never discharge out again on the grond surface.

Table 3 gives an additional summary of the volume by hole type for each EPA zone. Although the majority of the dry holes are found in Zone 7, dry holes of considerable size are found in Zones 2 and 3. Zone 5 contains the largest Type 2 holes, primarily the open pits along Short Creek.

Table 4 presents a summary of the estimated disposal space in the subsidence zones and open pits near Galena. Nearly two million cubic yards of disposal space appears available and does not even include one large open pit (#5-70P) or any of the 377 abandoned mine shafts in the area.

Table 5 shows a comparison of these field measurement results with the previous paper calculations done in June on the McCauley data. Although there are some variations for individual zones, the total volumes are very close.

Table 6 presents an analysis of the estimated disposal space and estimated surface mine waste from previous studies by EPA zone. There is more (over three times) than an adequate amount of disposal space within the whole Galena subsite to dispose of the waste rock portion of the surface mine waste. In fact, enough space exists to dispose of all the chat also.

All zones except Zone 1 have adequate void space to dispose of the waste rock fraction. Zones 1, 7, and 8 do not have quite enough space to dispose of all the surface mine waste. However, Zones 2, 3, 4, and 5 have significantly extra void space and material could be trucked to those areas. Waste rock and chat from the outlying areas would probably have to be trucked to the nearest zone for disposal since disposal space does not appear to exist in any significance at those locations.

In addition to removing a potential environmental hazard by disposing of the surface mine waste, the filling in of subsidence areas, open pits, and mine shafts will lessen the severe safety hazard and trash problem that these areas now present in the Galena area.

Table 2

Average Water Depth
in Measured Ponds

Location Number	Depth (Feet)
1-4	16
1-9	7
3-18	9
4-9	4
4-11	6
4-12(10)	48
5-5	19
5-8	26
5-11	28
5-120P	56
5-23	7
5-24	20
6-1	15
6-2	15
6-170P	33
7-20	27
7-32	15
8-15	10
8-15A	3
8-16	17

Table 3

Volume of Disposal Space
by Hole Type in Each EPA Zone

EPA Zone	Volume (yd^3) Type 1	Type 2 Above Water	Type 2 Below Water*	Type 3
1	3,133	14,429	7,914	-
2	181,178	95,780	- +	-
3	140,429	112,053	6,619 +	-
4	1,109	56,380	110,722 +	-
5	17,351	197,352	494,763 +	-
6	8,749	15,514	89,976 +	6,879
7	197,332	24,049	57,935 +	2,970
8	18,531	27,842	31,911 +	1,704
Total	567,812	543,339	799,840	11,553

* + sign means depth in some minor areas where water was not measured

Table 4

Estimated Disposal Space
for Surface Mine Waste
at Galena, Kansas

EPA Zone	Total Volume Available (yd^3)*
1	25,476
2	276,958
3	259,101
4	168,211
5	709,466
6	121,118
7	282,286
8	79,988
Outlying Areas	None Observed**
Total	1,922,604

* Includes space both above and below any standing water

** Some space is thought to exist in Area G1

Table 5

Comparison of Field Survey Results
with
Theoretical Volume Calculations from McCauley Data

EPA Zone	Field Survey Result (yd^3)	Theoretical Volume Calculations (yd^3)
1	25,476	14,863
2	276,958	297,248
3	259,101	184,936
4	168,211	134,847
5	709,466	803,499
6	121,118	39,532
7	282,286	312,680
8	79,988	43,839
Outlying Areas	-	14,304
Total	1,922,604	1,845,748

Table 6

Comparison of Estimated Disposal Space
with
Estimated Surface Mine Waste
at Galena, Kansas

EPA Zone	Estimated Disposal Space (yd^3)	Estimated Surface Waste Rock* (yd^3)	Mine Waste Chat (yd^3)
1	25,476	64,027	97,129
2	276,958	70,060	46,881
3	259,101	45,906	59,328
4	168,211	35,930	20,388
5	709,466	126,170	180,651
6	121,118	37,483	44,220
7	282,286	125,850	251,941
8	79,988	42,179	49,316
Outlying Areas	-	26,435	139,554
Total	1,922,604	574,040	889,408

* Includes waste rock, overburden, and stream sediment

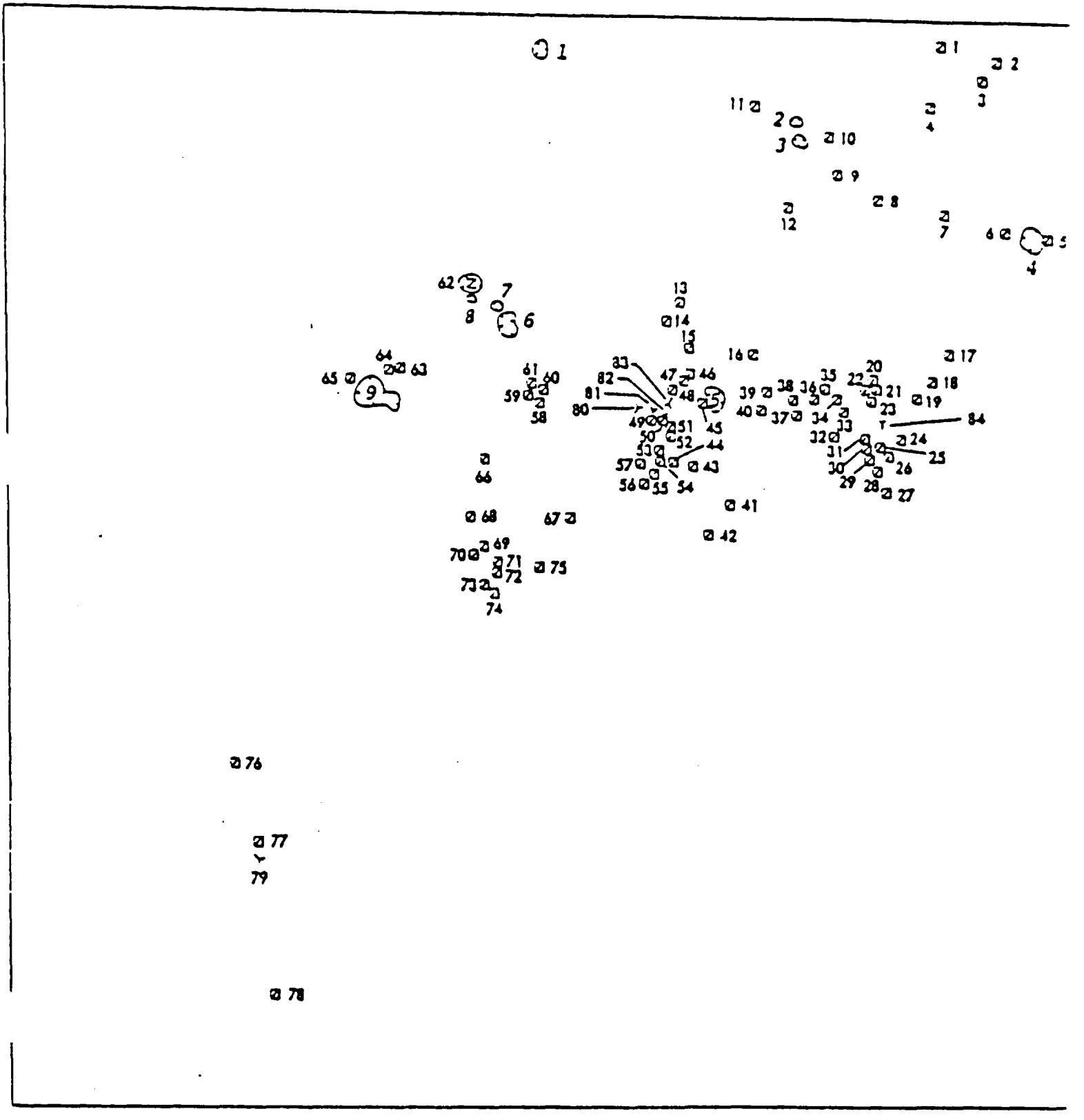
Conclusions

A detailed field survey of the Galena subsite indicates that a total of nearly two million cubic yards of disposal space exists in the subsidence zones and open pits of the subsite. In addition, 377 abandoned mine shafts are thought to exist. There appears to be more than an adequate amount of space available to dispose of the waste rock and in fact all the chat within the subsite. Field results closely parallel the 1983 McCauley data regarding location and volume of disposal space. Because of differences in disposal space and surface mine waste volumes within EPA zones, some trucking of materials between zones would be required.

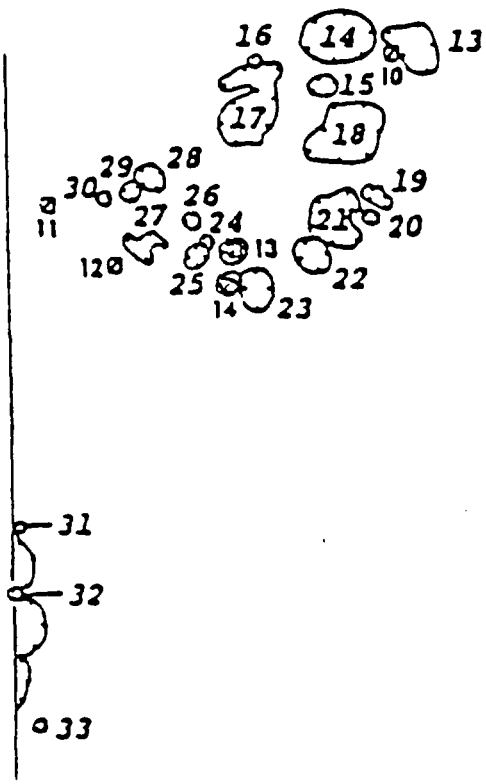
Although adequate disposal space appears available, the true availability of such may depend on the desires of the local landowners who either own the void space or who own the surface mine waste to be disposed of. Many locals consider some of the surface mine waste, particularly the chat, to be a valuable resource and permission for disposal may be hard to obtain.

APPENDIX A

Zone 1



Zone 2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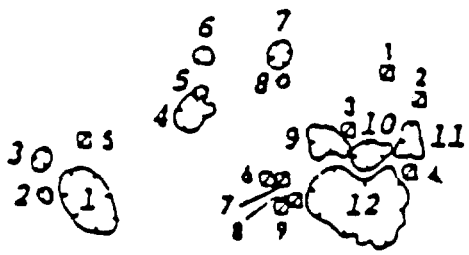
Zone 4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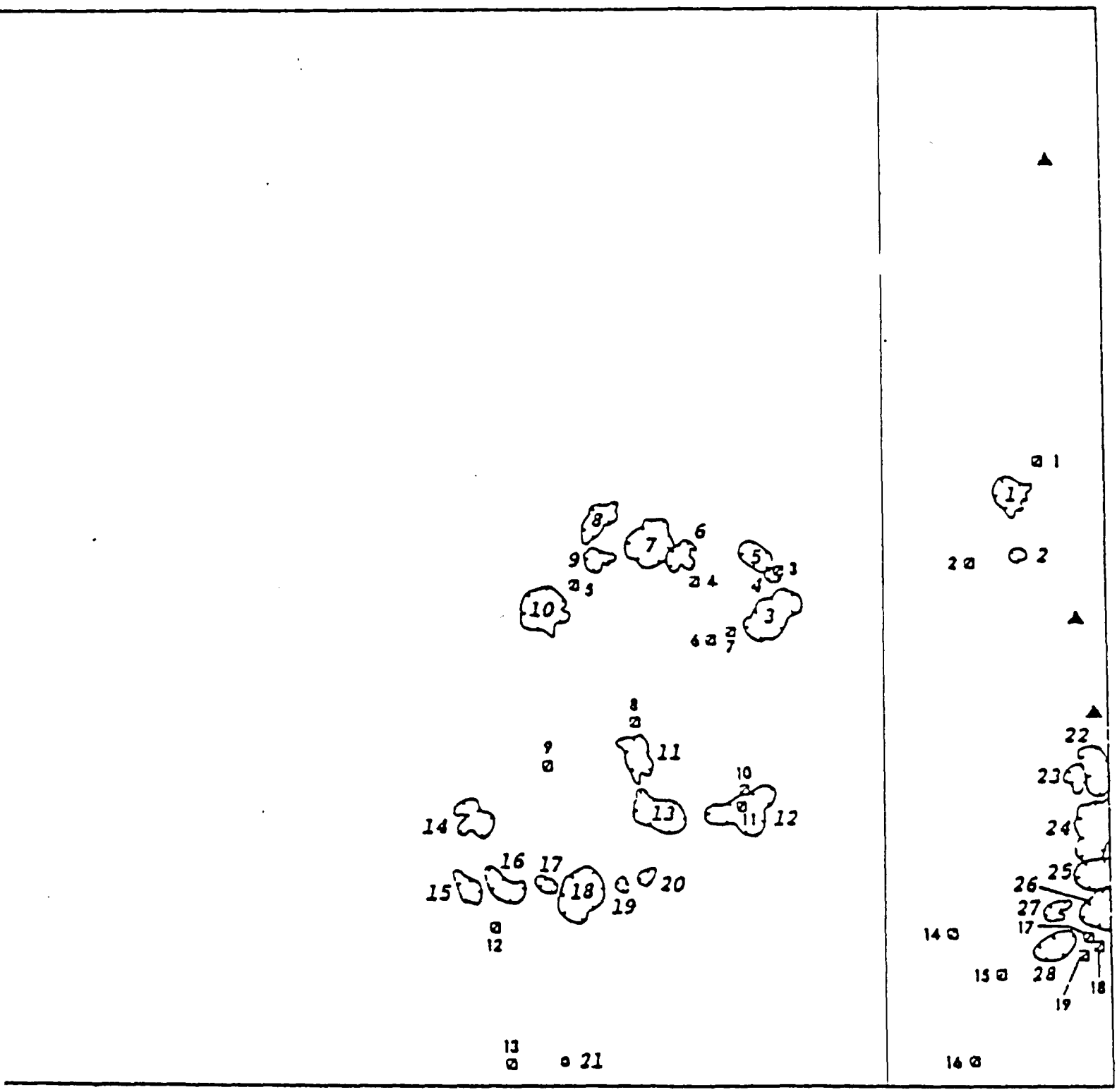
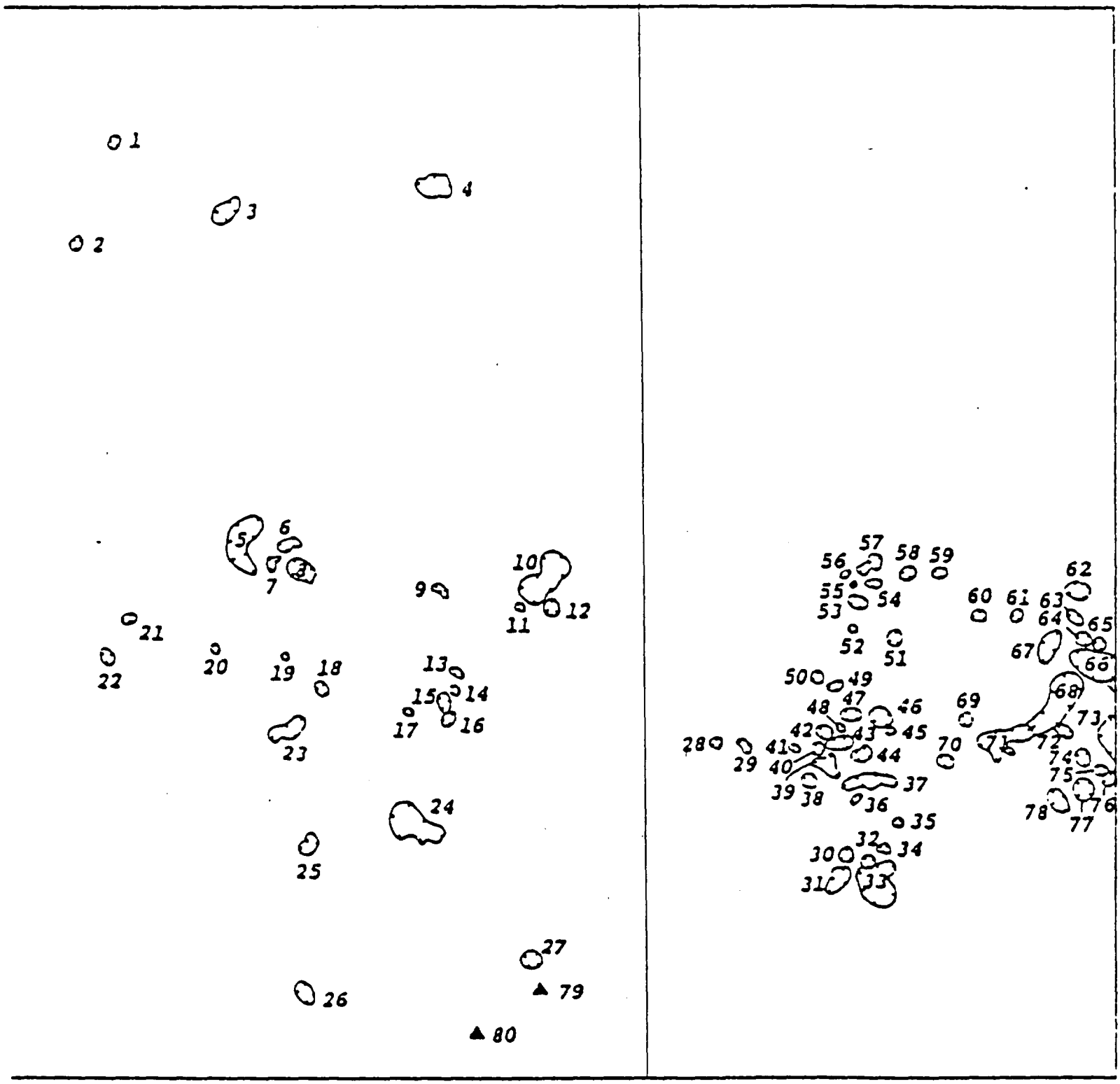
Zone 3

Zone 2



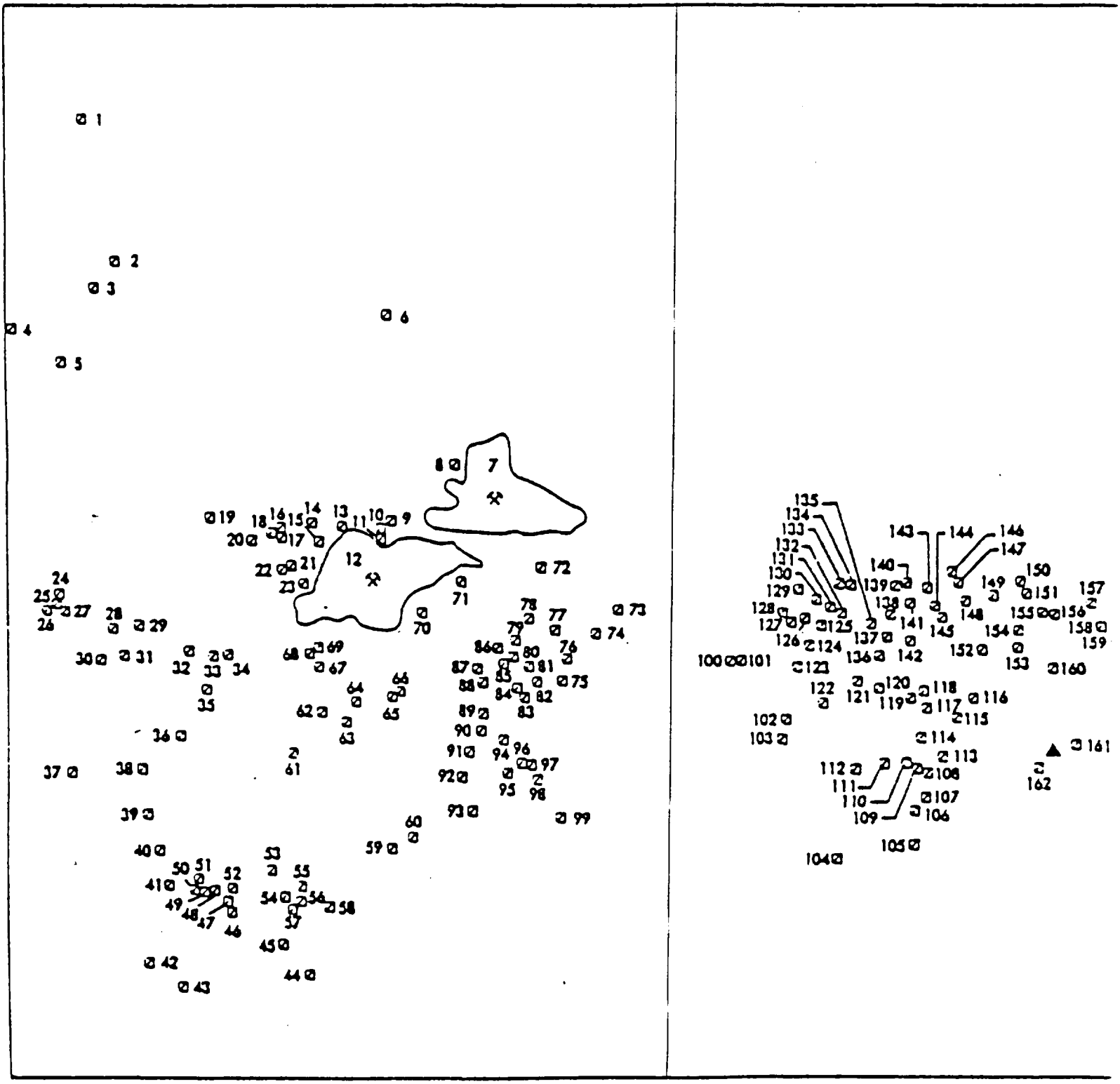
Zone 5

Zone 7B



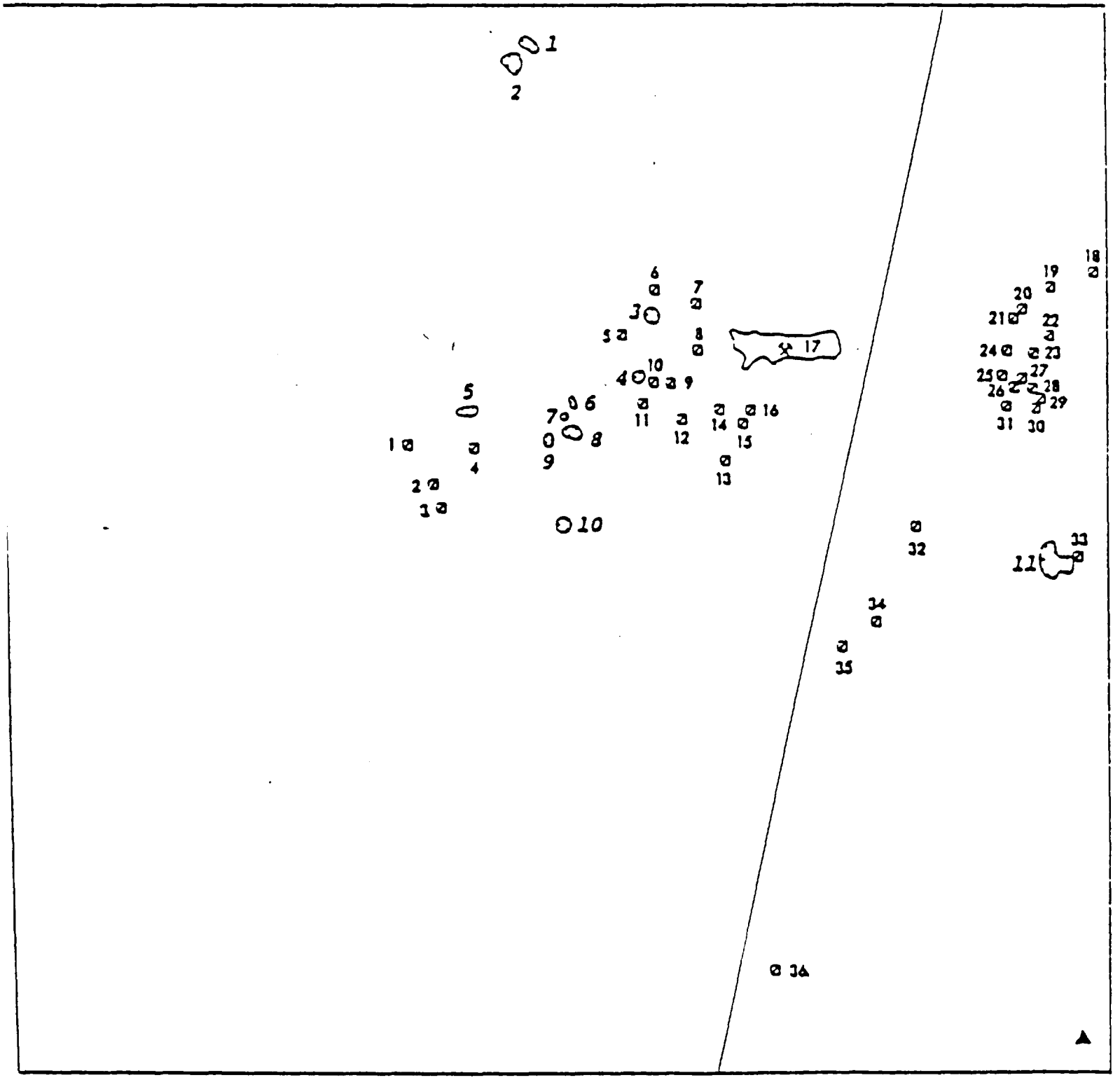
Zone 5

Zone 7B

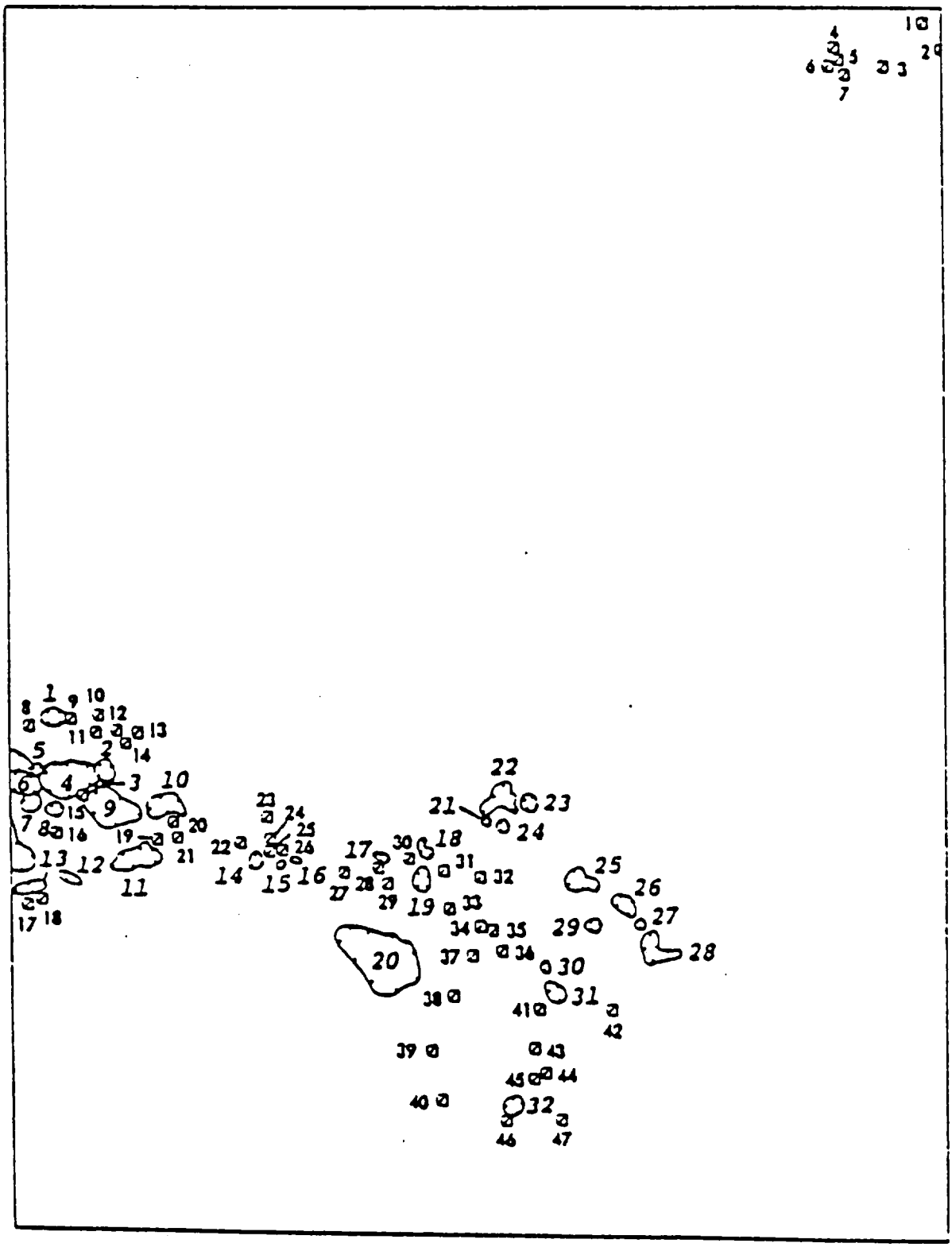


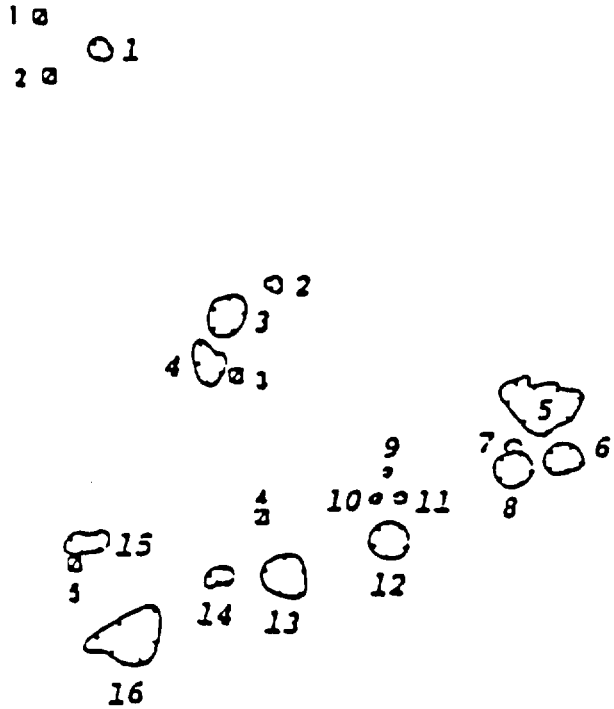
Zone 6

Zone 5



Zone 7A

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APPENDIX B

Zone 1 Volume (yd^3)

Location Number	Type 1 Disposal Areas	Type 2 Disposal Areas		Type 3 Disposal Areas	Grand Total
		Above Water	Below Water		
1-1	2,117	-	-	-	
1-2	159	-	-	-	
1-3	857	-	-	-	
1-4	-	5,765	5,405	-	
1-9	-	8,664	2,509	-	
Total	3,133	14,429	7,914	-	25,476

Location Number	Zone 2 Volume (yd^3)				
	Type 1 Disposal Areas	Type 2 Disposal Areas		Type 3 Disposal Areas	
		Above Water	Below Water		
Section 22					
2-1	12,241	-	-	-	
2-2	-	227	?	-	
2-22	11,828	-	-	-	
2-23	2,319	-	-	-	
2-24	34,884	-	-	-	
2-25	432	-	-	-	
2-26	35,138	-	-	-	
2-27	4,335	-	-	-	
2-28	10,284	-	-	-	
Section 23					
2-13	30,720	-	-	-	
2-14	-	51,640	-	-	
2-15	1,382	-	-	-	
2-18	-	42,205	-	-	
2-19	1,764	-	-	-	
2-20	768	-	-	-	
2-21	15,729	-	-	-	
2-22	5,227	-	-	-	
2-23	12,570	-	-	-	
2-25	-	830	-	-	
2-26	-	403	?	-	
2-27	952	-	-	-	
2-29	-	475	-	-	
2-30	605	-	-	-	
					Grand Total
Total	181,178	95,780	-	-	276,958

Location Number	Zone 3 Volume (yd^3)				
	Type 1 Disposal Areas	Type 2 Disposal Areas		Type 3 Disposal Areas	
		Above Water	Below Water		
3-3	-	45,185	-	-	
3-4	2,506	-	-	-	
3-5	7,638	-	-	-	
3-6	12,696	-	-	-	
3-7	-	10,297	-	-	
3-8	20,808	-	-	-	
3-9	-	9,033	-	-	
3-10	-	12,702	-	-	
3-11	12,476	-	-	-	
3-12	28,905	-	-	-	
3-13	16,709	-	-	-	
3-14	15,348	-	-	-	
3-15	5,202	-	-	-	
3-16	11,616	-	-	-	
3-17	3,466	-	-	-	
3-18	-	34,836	6,619	-	
3-19	1,659	-	-	-	
3-20	1,400	-	-	-	
Total	140,429	112,053	6,619	-	Grand Total 259,101

Zone 4 Volume (yd^3)

Location Number	Type 1 Disposal Areas	Type 2 Disposal Areas		Type 3 Disposal Areas	Grand Total
		Above Water	Below Water		
4-1	-	30,246	?	-	
4-4	-	4,839	-	-	
4-6	1,109	-	-	-	
4-7	-	2,061	-	-	
4-8	-	219	-	-	
4-9	-	2,098	2,248	-	
4-11	-	2,397	2,112	-	
4-12(10)	-	14,520	106,362	-	
Total	1,109	56,380	110,722	-	168,211

Location Number	Zone 5 Volume (yd^3) Type 1 Disposal Areas	Type 2 Disposal Areas Above Water	Type 2 Disposal Areas Below Water	Type 3 Disposal Areas	Grand Total
Section 15					
5-11	-	13,707	38,380	-	
Section 14					
5-2	323	-	-	-	
5-4	8,365	-	-	-	
5-5	-	7,615	18,085	-	
5-6	-	1,776	?	-	
5-7	-	838	?	-	
5-7OP	-	48,400	?	-	
5-8	-	2,447	3,510	-	
5-9	-	1,290	?	-	
5-10	-	11,616	?	-	
5-11	522	-	-	-	
5-12	1,426	-	-	-	
5-12OP	-	72,439	405,656	-	
5-13	675	-	-	-	
5-14	591	-	-	-	
5-15	1,274	-	-	-	
5-16	1,452	-	-	-	
5-18	-	635	-	-	
5-19	-	209	?	-	
5-20	-	177	?	-	
5-21	-	1,463	?	-	
5-22	-	2,719	?	-	
5-23	-	3,642	4,249	-	
5-24	-	21,773	24,883	-	
5-25	2,723	-	-	-	
5-26	-	6,606	?	-	
Total	17,351	197,352	494,763	-	709,466

Zone 6 Volume (yd^3)

Location Number	Type 1 Disposal Areas	Type 2 Disposal Areas		Type 3 Disposal Areas	Grand Total
		Above Water	Below Water		
6-1	-	-	-	2,941	
6-2	-	-	-	3,938	
6-3	-	1,882	?	-	
6-4	730	-	-	-	
6-5	839	-	-	-	
6-6	681	-	-	-	
6-7	506	-	-	-	
6-8	2,178	-	-	-	
6-9	1,016	-	-	-	
6-10	2,799	-	-	-	
6-17OP	-	13,632	89,976	-	
Total	8,749	15,514	89,976	6,879	121,118

Zone 7A Volume (yd^3)

Location Number	Type 1 Disposal Areas	Type 2 Disposal Areas Above Water	Type 2 Disposal Areas Below Water	Type 3 Disposal Areas	Grand Total
7-1	2,356	-	-	-	
7-2	969	-	-	-	
7-3	373	-	-	-	
7-4	7,440	-	-	-	
7-5	666	-	-	-	
7-6	3,888	-	-	-	
7-7	1,532	-	-	-	
7-8	830	-	-	-	
7-9	14,524	-	-	-	
7-10	5,125	-	-	-	
7-11	25,605	-	-	-	
7-12	780	-	-	-	
7-13	1,987	-	-	-	
7-14	-	2,592	?	-	
7-15	97	-	-	-	
7-16	102	-	-	-	
7-18	2,700	-	-	-	
7-19	703	-	-	-	
7-20	-	21,457	57,935	-	
7-22	4,800	-	-	-	
7-23	864	-	-	-	
7-24	416	-	-	-	
7-25	2,352	-	-	-	
7-26	530	-	-	-	
7-27	49	-	-	-	
7-28	871	-	-	-	
7-29	25	-	-	-	
7-32	-	-	-	2,970	
Total	79,584	24,049	57,935	2,970	164,538

Zone 7B Volume (yd^3)

Location Number	Type 1 Disposal Areas	Type 2 Disposal Areas Above Water	Type 2 Disposal Areas Below Water	Type 3 Disposal Areas	Grand Total
7-30	1,298	-	-	-	
7-31	9,600	-	-	-	
7-32	1,106	-	-	-	
7-33	12,918	-	-	-	
7-34	576	-	-	-	
7-35	31	-	-	-	
7-37	5,358	-	-	-	
7-38	704	-	-	-	
7-39	2,640	-	-	-	
7-40	864	-	-	-	
7-42	1,200	-	-	-	
7-43	1,340	-	-	-	
7-44	1,875	-	-	-	
7-45	162	-	-	-	
7-46	2,765	-	-	-	
7-47	903	-	-	-	
7-48	243	-	-	-	
7-49	553	-	-	-	
7-50	576	-	-	-	
7-51	1,374	-	-	-	
7-52	853	-	-	-	
7-53	726	-	-	-	
7-54	203	-	-	-	
7-56	150	-	-	-	
7-57	2,052	-	-	-	
7-58	1,670	-	-	-	
7-59	795	-	-	-	
7-60	339	-	-	-	
7-61	1,089	-	-	-	
7-62	1,211	-	-	-	
7-63	576	-	-	-	
7-64	1,109	-	-	-	
7-65	762	-	-	-	
7-66	7,873	-	-	-	
7-67	3,591	-	-	-	
7-68	16,138	-	-	-	
7-69	1,560	-	-	-	
7-70	1,923	-	-	-	
7-71	8,213	-	-	-	
7-72	973	-	-	-	
7-73	10,443	-	-	-	
7-74	2,548	-	-	-	
7-75	1,129	-	-	-	
7-77	2,996	-	-	-	
7-78	2,540	-	-	-	
Total	117,748	-	-	-	117,748

Zone 8 Volume (yd^3)

Location Number	Type 1 Disposal Areas	Type 2 Disposal Areas		Type 3 Disposal Areas	
		Above Water	Below Water		
8-1	727	-	-	-	
8-2	-	287	?	-	
8-3	1,998	-	-	-	
8-4	-	6,094	?	-	
8-5	7,560	-	-	-	
8-6	3,942	-	-	-	
8-7	706	-	-	-	
8-8	1,815	-	-	-	
8-9	-	393	?	-	
8-10	394	-	-	-	
8-11	470	-	-	-	
8-12	-	1,833	?	-	
8-13	-	3,232	?	-	
8-14	919	-	-	-	
8-15	-	1,588	7,540	-	
8-15A	-	-	-	1,704	
8-16	-	14,415	24,371	-	
Total	18,531	27,842	31,911	1,704	Grand Total 79,988